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U. S. DEPARTMENT OF AGRICULTURE.

REPORT

OF

THE MICROSCOPIST

FOR

THE YEAR 1889.

Taylor

AUTHOR'S EDITION.

FROM THE ANNUAL REPORT OF THE DEPARTMENT OF AGRICULTURE
FOR THE YEAR 1889.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

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REPORT OF THE MICROSCOPIST.

Sir: I have the honor to submit herewith my eighteenth annual report.

The work of this division for the past year has been largely in the line of original investigations relating to the microscopy of food-stuffs, including the condiments of commerce. Micro-photographs and colored drawings with the camera lucida have been made, which represent the characteristics of certain pure food products and of the adulterants used in them.

Tea has received special attention; methods are pointed out which show how foreign leaves may be detected in a sample of adulterated tea. This paper is highly illustrated with micro-photographs and colored drawings which accompany my report.

Olive oil has also been the subject of investigation, and in this connection fully fifteen hundred experiments have been made relating to the color reactions of the food and medicinal fats and oils, with a view to discover new and simple methods of detecting fraudulent imitations. In this line of research I have made several discoveries which promise to be of great value in the future.

The microscopy of various textile fibers has also received consideration.

The continued demand for my report on the edible mushrooms of the United States would indicate that this subject is one of considerable interest to the public. A chart is in process of preparation which will show how to discriminate between poisonous and nutritious varieties.

About one thousand letters have been answered on various subjects pertinent to the work of the division during the year. Agreeably to an order from the Secretary of Agriculture a special exhibit was prepared for the Paris Exposition, relating to food adulterations and comprising certain instruments of precision, of my invention, relating to and facilitating the labor of the microscopist, for which a silver medal was awarded.

Respectfully submitted.

Thomas Taylor,
Microscopist.

Hon. J. M. Rusk,
Secretary of Agriculture.

TEA AND ITS ADULTERATIONS.

ORIGINAL MICROSCOPIC INVESTIGATIONS.

Notwithstanding the numerous microscopic investigations which have been made during the last twenty years, relating to the external and internal structure of the tea leaf, with a view of being able to distinguish it from the leaves of other plants, there seems to be a necessity for further investigation in this direction, judging from my recent observations in this line of research.

In making preliminary examinations of tea-leaf dissections, I discovered peculiarly formed, isolated cells (polarizing bodies) seemingly having no connection whatever with the general cell-structure of the leaf. On looking up the various writers on food adulterations, I found the following notice of these peculiar cells termed "idioblasts" in Blythe's Analysis of Foods:

> Idioblasts are long, tough, tenacious, branched cells, which seem to act as pillars or beams, keeping the two layers of the leaf apart; they do not occur in any other leaf with which the tea-leaf is likely to be confused, so that their presence would indicate tea, their absence would point to foreign leaves. A very convenient method of detecting "idioblasts" is given by Moeller: Small fragments of the leaf are warmed in a very strong solution of caustic potash and then placed under the thin covering glass and pressed firmly.

They must be viewed under suitable powers of the microscope. Botanists have given various names to the "idioblasts," such as "scleroblasts," "scelerenchyma," and "stone-cells" (so called after the stony bodies found in the flesh and stalk of many pears which are composed of them). Their function is not positively known. Du Bary, Sachs, Bessey, and others, give full information in their respective botanical works regarding their presence in many plants and their supposed use. The general structure of the tea-leaf presents to the ordinary observer nothing of peculiar importance, but on closer inspection with even the low powers of the miscroscope an experienced microscopist will easily detect these cells, especially by means of polarized light, in the transverse and longitudinal sections of the midrib of the leaf. They are also found scattered in great numbers, irregularly, throughout the body of the leaf. The stone-cells of the Camellia japonica, which belongs to the tea family, differ slightly from those found in the leaf of the tea-plant. The leaves of some species of camellia, of which it is said by Carpenter there are many, are said to have been used as adulterants of tea by the Chinese merchants about twenty years ago. The leaves of the species japonica are very thick and fleshy as compared with the tea-leaf proper, and therefore may be distinguished from the latter.

The presence of stone-cells in the leaf of the tea-plant, and their absence, according to Blythe, in all other plant leaves not of the tea family used as adulterants of tea, if correct, is an important factor to begin with. My experience, in this respect, agrees with that of Blythe. I have examined the following leaves used as adulterants of tea, viz, willow, sloe, beech, Paraguay tea, ash, black currant, Camellia japonica, two species of hawthorn (one the common English hawthorn) and raspberry, but find in them no trace of these peculiar cells, except in the case of the camellia, which belongs to the tea family. I find, however, that many of the leaves above mentioned contain a class of crystals not observed in the tea-leaf, viz, crystals of oxalate of lime, while the willow and others contain the starry forms known as "raphides," which are also found in the tea-leaf.

Raphides are aggregations of acicular or needle-like crystals common to many plant leaves said to be used in tea adulterations. Blythe has alluded to them.

While it is well known that only the small or young tea-leaves are generally employed in the commercial product, the structural characteristics of the larger leaves are more easily differentiated and are quite suggestive of what to expect in the more delicate forms. Students should begin with the larger leaves. For these investigations leaves from the living plant are required, which I have readily obtained, in all stages of growth, from the propagating grounds of this Department.

"The mesophyl or parenchyma of the tea-leaf contains two kinds of cells, the one being a very regular single or double row, filled with chlorophyl, just beneath the upper epidermal layer, whilst a spongy parenchyma containing large spaces occupies the rest of the leaf thickness." (Blythe.) Having ascertained the order and form of cell arrangement in the mature leaf, the investigator proceeds with the knowledge thus acquired to the more delicate tea-leaves of commerce. The first difficulty met with in this experiment arises from the changed condition of the leaf, the result of manipulation. The leaf in its natural state is firm and without curl, while as manufactured it is dry, fragile, and much of it in the form of powder. The leaves most favorable for examination, however, are those compactly rolled. With a little experience and patient perseverance the artificial conditions and attended difficulties are easily overcome. The simple process of infusion will remove much of the difficulty. It will be found that many of the rolled leaves are entire; these should be separated from fragmentary leaves, but all fragments should be examined, and it is a good plan to assort the different forms, placing each lot of a similar kind by itself. Many of the fragments will exhibit the edges of the leaf entire. Secure a sufficient number of them by means of any suitable cement, on slips of glass 3 by 1 inch, and examine the indented edges (serrations), using low powers of the microscope. Make drawings of them and compare with the genuine tea-leaf. Transverse and longitudinal sections of the leaves should be made and mounted in the usual way for observation and comparison under the microscope and for purposes of photography. Portions of the epidermis may be easily removed by macerating or scraping the leaf, and when taken from the green leaf are better for photography than specimens obtained from the leaf by the use of chemicals. In the subjoined plates will be found some of the marked characteristics of the tea-leaf as well as of leaves used as adulterants of tea. It is hoped that by means of these illustrations those engaged in this line of work will be able to acquire a better knowledge of the simplest methods of determining what is tea and what are adulterations of tea.

HOW TO DETECT STONE-CELLS IN THE TEA-LEAF.

I have tested Moeller's method, but find it deficient in one particular. He says: "Treat the leaves with a warm and strong solution of caustic potash and mount with a thin covering glass and press firmly." The student will experience great difficulty in discovering stone-cells by this method. Modify the method as follows: Boil the tea or other suspected leaves in a solution of strong caustic potash or soda for three minutes, allow the solution to cool, remove a

leaf or portion of leaf, as the case may be, by means of forceps, placing the specimen on a slip of glass 3 by 1 inch with a second slip of glass of the same dimensions over and in contact with the first slip, thus covering the specimen; press firmly, using slight friction, so that the leaf will appear as a mere stain between the glass slips. This method, while it disintegrates the cell tissue, does not impair the outline of the stone-cells, of which numerous groupings may be observed. Leaf hairs are frequently distinctive, and not being injured by the caustic potash solution, are often observed in great profusion, indicating sometimes the species of plant to which the leaf belongs, and thus assisting in some cases in distinguishing tea-leaves from those leaves used as adulterants. In order to become familiar with the general appearance of the entire cell arrangement of the tea-leaf, it will be necessary to devote considerable time to the work, familiarizing one's self with the many forms observed under both high and low powers of the microscope, noting not only the cell forms but also the relative size of the cells. This will be found particularly valuable in making examinations of what is sold for tea-dust, which may contain very little tea and consist mostly of raspberry leaves or other worthless substance purposely reduced to a fine powder to make detection difficult. But when it is considered that a particle of this tea-dust, so called, measuring only the one-hundredth of an inch in diameter, if magnified three hundred times will appear under the microscope 3 inches in diameter, it will be seen that the cell-structure may be easily observed and its character ascertained.

The early investigators of adulterated food supplies have enumerated may substances found in tea, but it is acknowledged that many adulterants formerly used are now discarded. The truth is, that many of the adulterants were so easily detected and punishment of the offender so certainly followed that the mixer was forced either to abandon the practice or so to modify it by the use of harmless substances that the question now is resolved simply into that of the consideration of relative cost. That is to say, the principal question which interests the consumer, and especially the poorer classes, relates to economy and not to the poisonous character of the adulterant. If a person pay $1 for a pound of so-called tea containing half a pound of black currant leaves costing only 2 cents, it is evident that the purchaser has paid for half a pound of tea nearly $1. The poor are generally the greatest sufferers in this way, as they deal generally on credit and frequently with irresponsible persons. Most of the teas shipped from Japan to the United States are now artificially colored. Formerly this was not the case. In the early years of the trade, say from 1859 to 1869, the manipulation of Japan teas by the exporter was confined to a simple refiring, which was necessary in order to cure the leaf sufficiently to enable it to endure transportation through the tropics and to retain its qualities while in store. This process alone required large establishments and a considerable plant, as well as important outlays for labor and fuel. But the leaf was improved by the expenditure, and Japan teas were then shipped in their natural condition and honestly called "uncolored." About 1870, however, consumers began to call for higher color than any natural process would furnish, and although this demand was long resisted by the shippers in Japan, and at some loss to themselves, yet ultimately it prevailed, and for some years past artificial coloring has been the rule, so that Japan teas, which are naturally of a

blackish-green color, are now made to resemble the bluish-gray or grayish-blue teas shipped from China as "green teas."

The materials used to produce these unnatural shades are not very pernicious, it is said, being nothing worse as a general rule than indago and gypsum, but they certainly add nothing to the value of the tea-leaves for drinking purposes, while they do add considerably to their cost. There is nothing to be said in favor of the practice, except that dealers in America prefer teas of that description. Their doing so is probably explained by the fact that in teas so colored coarse leaves may pass without detection, and this no doubt is the cause of the gradual deterioration of the quality of Japan teas exported to America during recent years. The adulteration will probably continue as long as consumers buy, in America, teas only in accordance with the appearance of the leaf, regardless of its infusive qualities, and as long as the simple secret of making the infusion is so little understood in our country. To the Japanese, who value tea for its fragrance and delicacy and who are careful to draw these qualities from the leaf by the use of pure water and nice vessels, the article is an abomination, and they naturally conclude that the quality of the leaf which is subjected to such treatment is not important. According to a late United States consular report, the American demand for the uncolored teas known as "basket-fired" has latterly increased; and it would be as advantageous to the consumer in the United States as it would be gratifying to most shippers in Japan, if this inclination to return to the honest, uncolored teas, were to become general, for it would certainly result in greater discrimination in the picking and preparation of the leaf in Japan, and would afford consumers better teas at lower prices, would restrict the supply to good teas only, and would revive the favor which Japan teas formerly enjoyed in the American market, as compared with the highly colored teas of China.

In accordance with your request, I read an abstract of my paper on tea and its adulterations before the Society of American Microscopists, in Buffalo, N. Y., in August, 1889. The secretary of the society informs me that the paper will be published in the society's volume of proceedings for 1889.

PLATE 1.

FIG. 1 represents the epidermal layer of the lower surface of the tea-leaf, showing the "breathing pores" or stomata in the intercellular spaces. The green portion represents the palisade cells charged with chlorophyl.

FIG. 2. Loose cells containing chlorophyl. (A) A stone-cell or idioblast as seen by polarized light, under high powers of the microscope; found in the fleshy part of the leaf.

PLATE 2.

FIG. 3 represents the internal structure of a portion of the leaf showing stone-cells, loose cells, vascular bundles, raphides, and oil globules, under polarized light.

FIG. 4. The epidermal layer, upper surface of the tea-leaf, in which I have not observed stomata.

PLATE 3.

Five stone-cells, as seen by polarized light in a longitudinal section of the midrib of a tea-leaf. This section was only one-quarter of an inch in length, in which all these cells were observed. The stone-cells of the tea-leaf generally average about one-hundredth of an inch in length and are polarizing bodies. If subjected to the action of caustic potash their polarizing property is greatly impaired.

PLATE 4.

FIG. 5 represents a cross-section of a leaf of Camellia japonica showing the position of the stone-cells within it.

FIG. 6. Stone-cells in a cross-section of a tea-leaf.

FIG. 7. The epidermal layer of the lower surface of a leaf of Camellia japonica, showing stomata in the inter-cellular spaces.

PLATE 5.

FIG. 8. The true tea-leaf, showing its characteristic venations.

FIG. 9. Leaves of the black currant, said to be used as an adulterant of tea.

PLATE 6.

Outline sketches of some of the leaves said to be used as adulterants of tea. In the natural condition these leaves vary very much in depth of color. The Sloe and Paraguay tea-leaves are dark green, the beech-leaf is light yellowish-green. By curing and infusion these leaves are changed to a dark greenish-brown hue.

PLATES 7 AND 8

Exhibit the distinctive serrations of the plant leaves used as adulterants of tea, highly magnified. A, A, Tea; B, Willow; C, D, Hawthorn; E, Paraguay tea; F, Sloe; G, Black Currant; H, Ash; I, Beech; J, Camellia japonica. The leaves of the raspberry are said to be used in this country in large quantities in the adulteration of tea. This will be investigated.

MICROSCOPIC INVESTIGATION OF THE TEA LEAF.

LOWER EPIDERMIS OF LEAF, SHOWING THE STOMATA AND CHLOROPHYL CELLS.

Fig. I

"STONE CELL" IN CENTER OF THE LEAF. Fig 2

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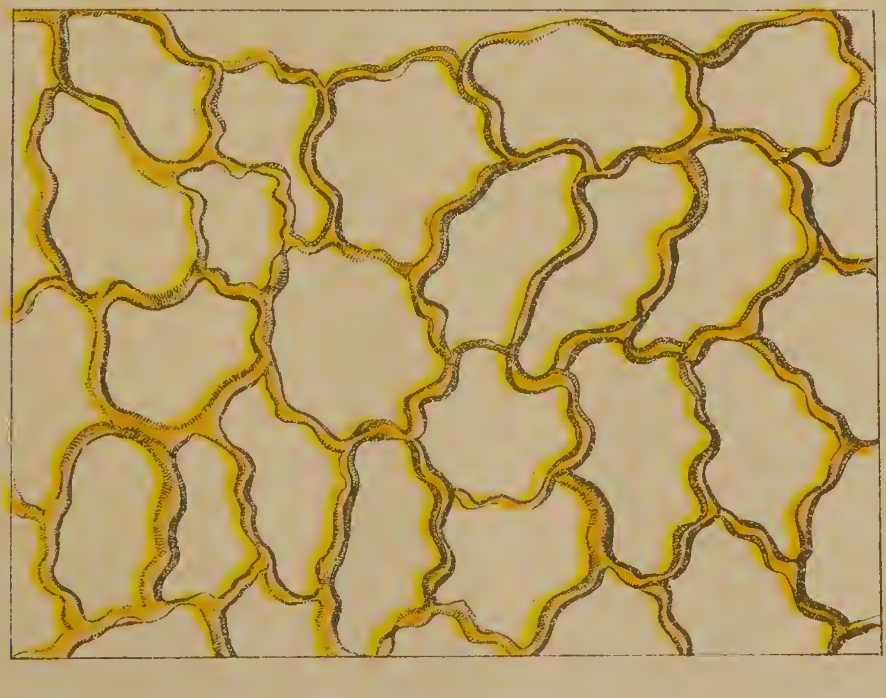
MICROSCOPIC INVESTIGATION OF THE TEA LEAF.

"STONE CELLS" OBSERVED AMONG THE LOOSE CELLS OF THE LEAF

Fig. 3

Fig 4

UPPER EPIDERMIS OF THE LEAF.



T. Taylor del.

Sackett & Wilhelms Litho Co. New York

MICROSCOPIC INVESTIGATION OF THE TEA LEAF.
SCLERENCHYMA OR "STONE CELLS" OF THE MIDRIB.
Fig. 5

X300

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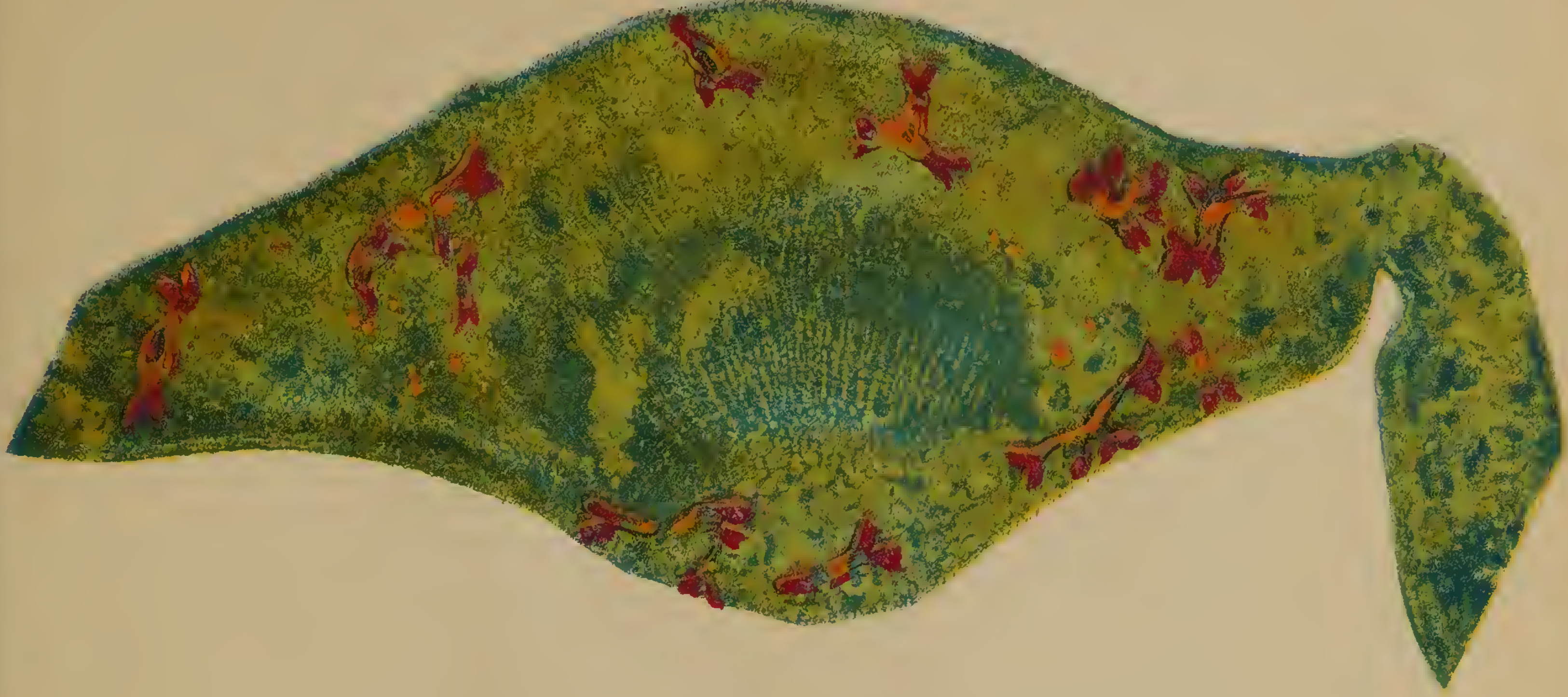
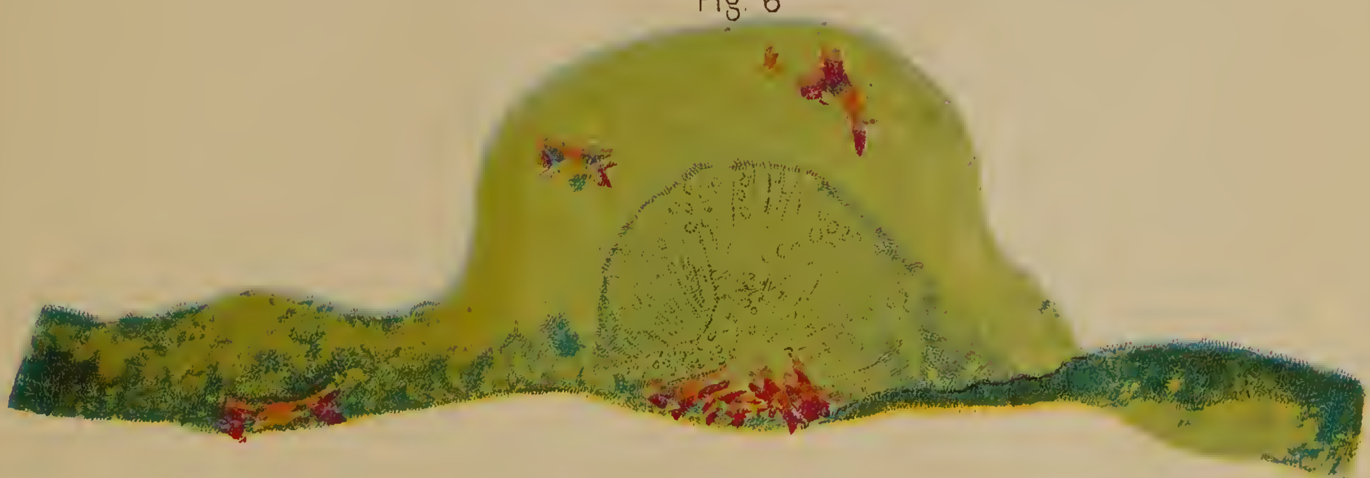
MICROSCOPIC INVESTIGATION OF THE TEA LEAF.

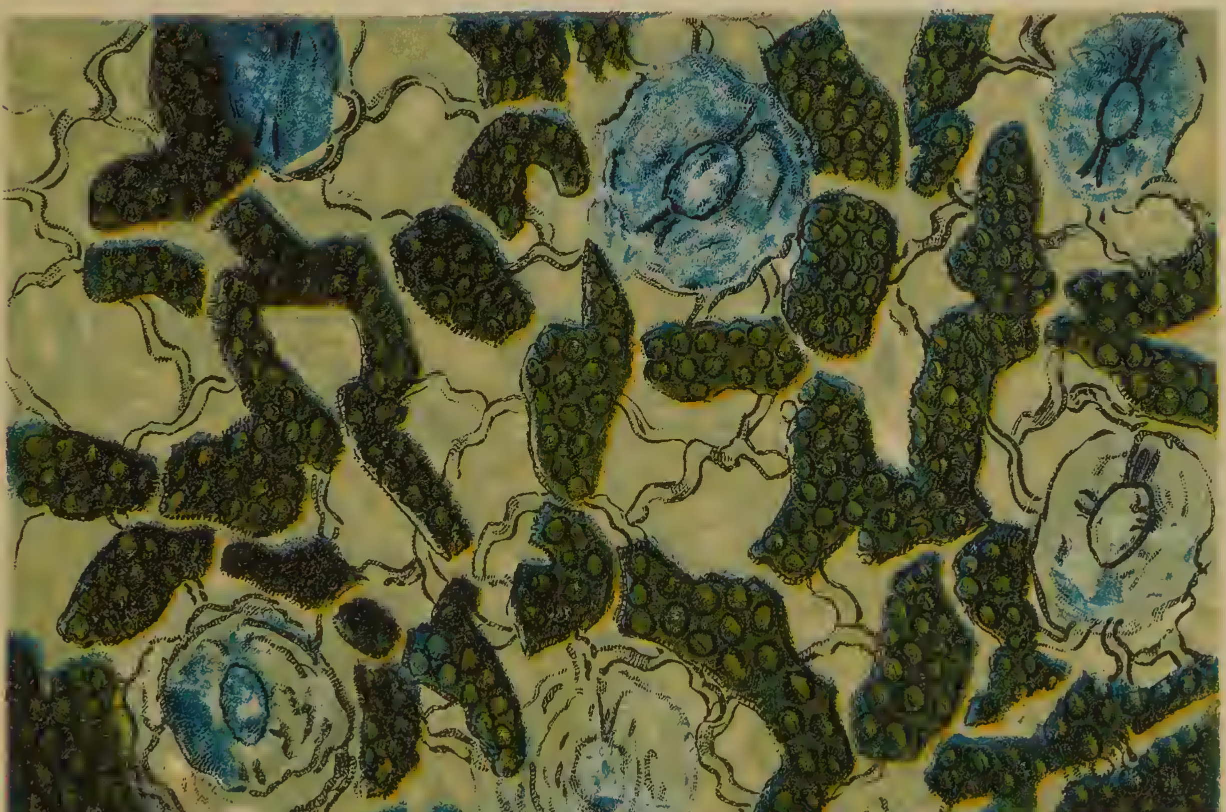
CROSS SECTION OF CAMELLIA JAPONICA LEAF SHOWING STONE CELLS.
Fig. 5



CROSS SECTION OF TEA LEAF SHOWING STONE CELLS.
Fig. 6



STOMATA OF LEAF OF CAMELLIA JAPONICA.
Fig. 7



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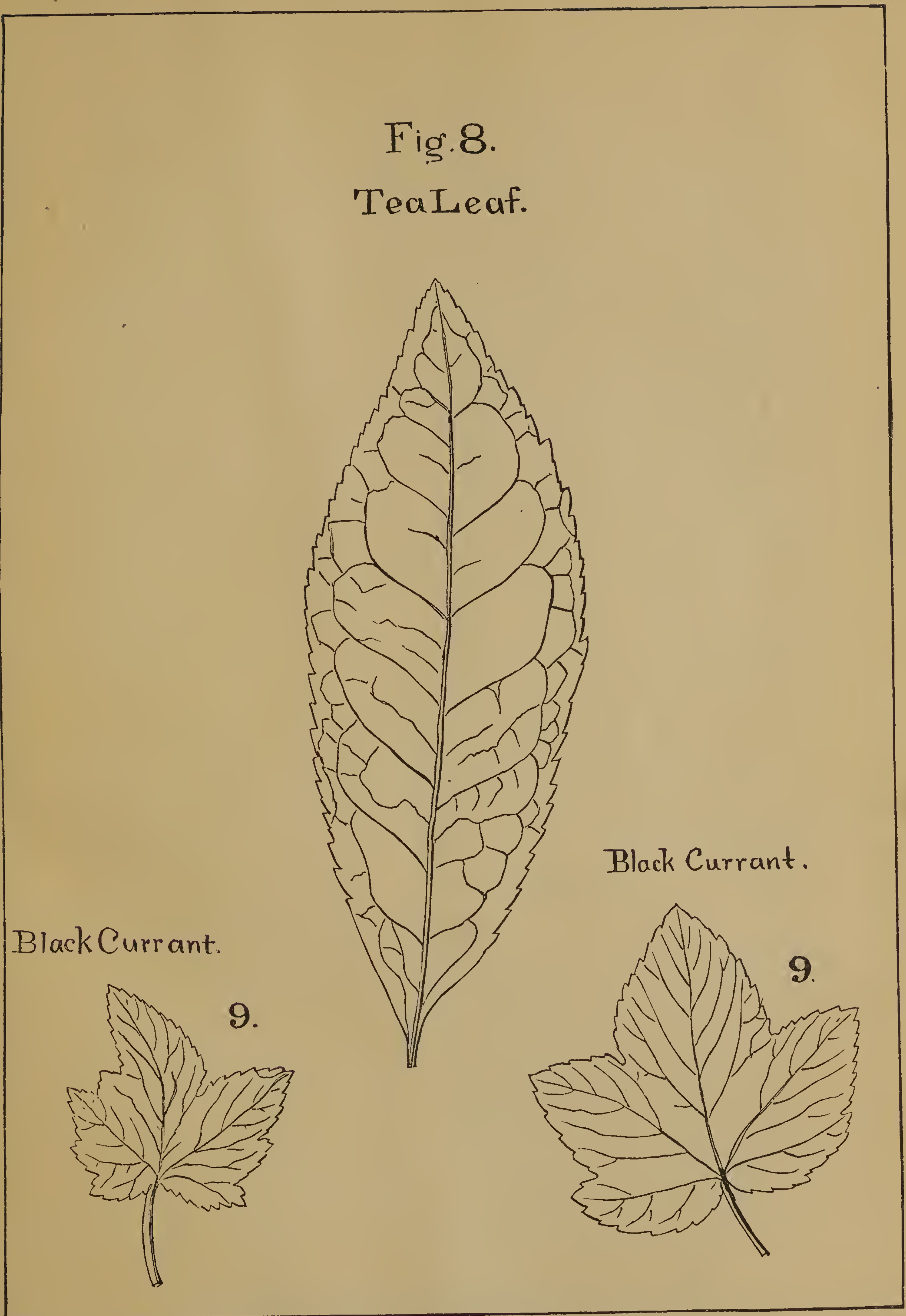

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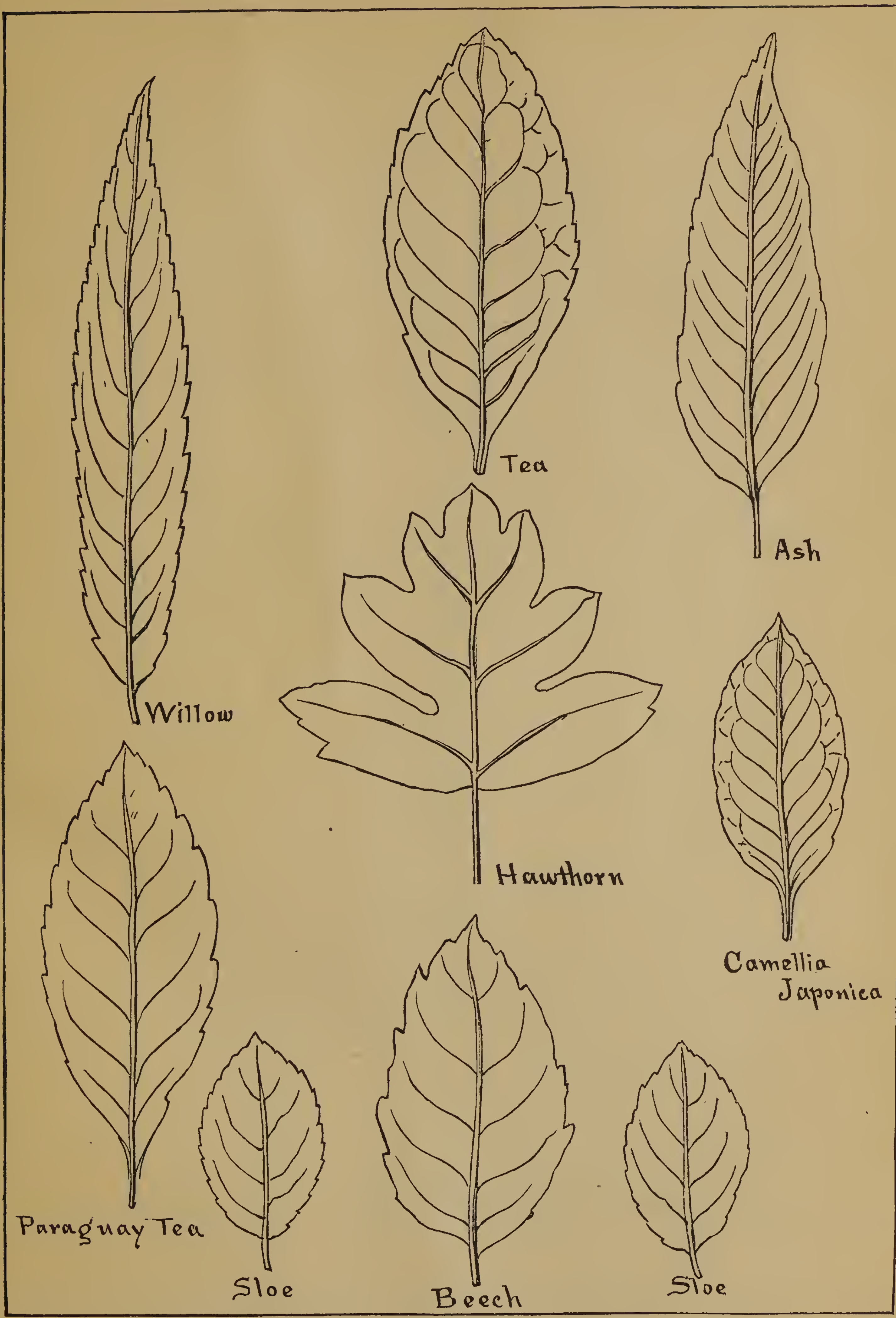
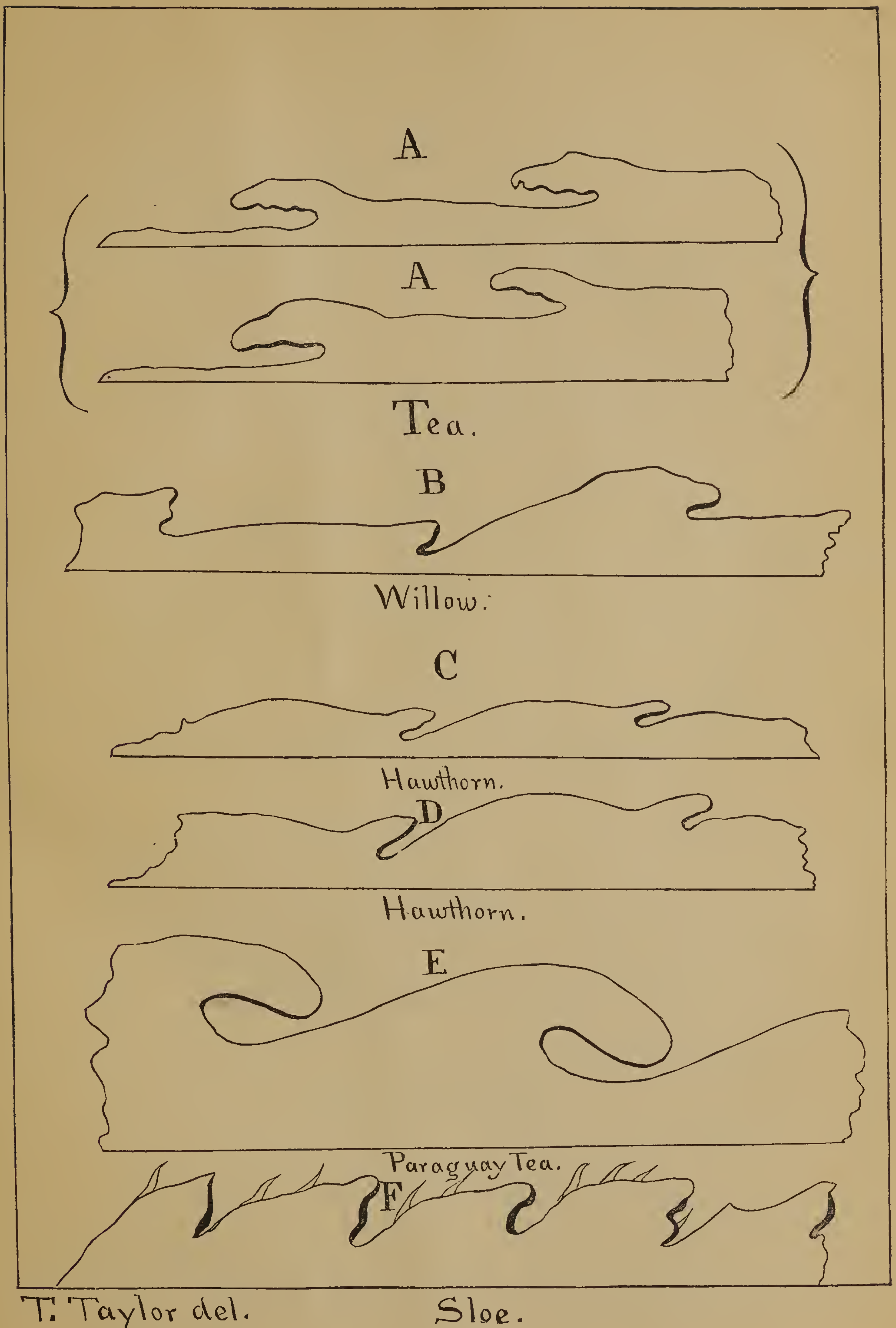
TEA-LEAF AND ITS ADULTERANTS.



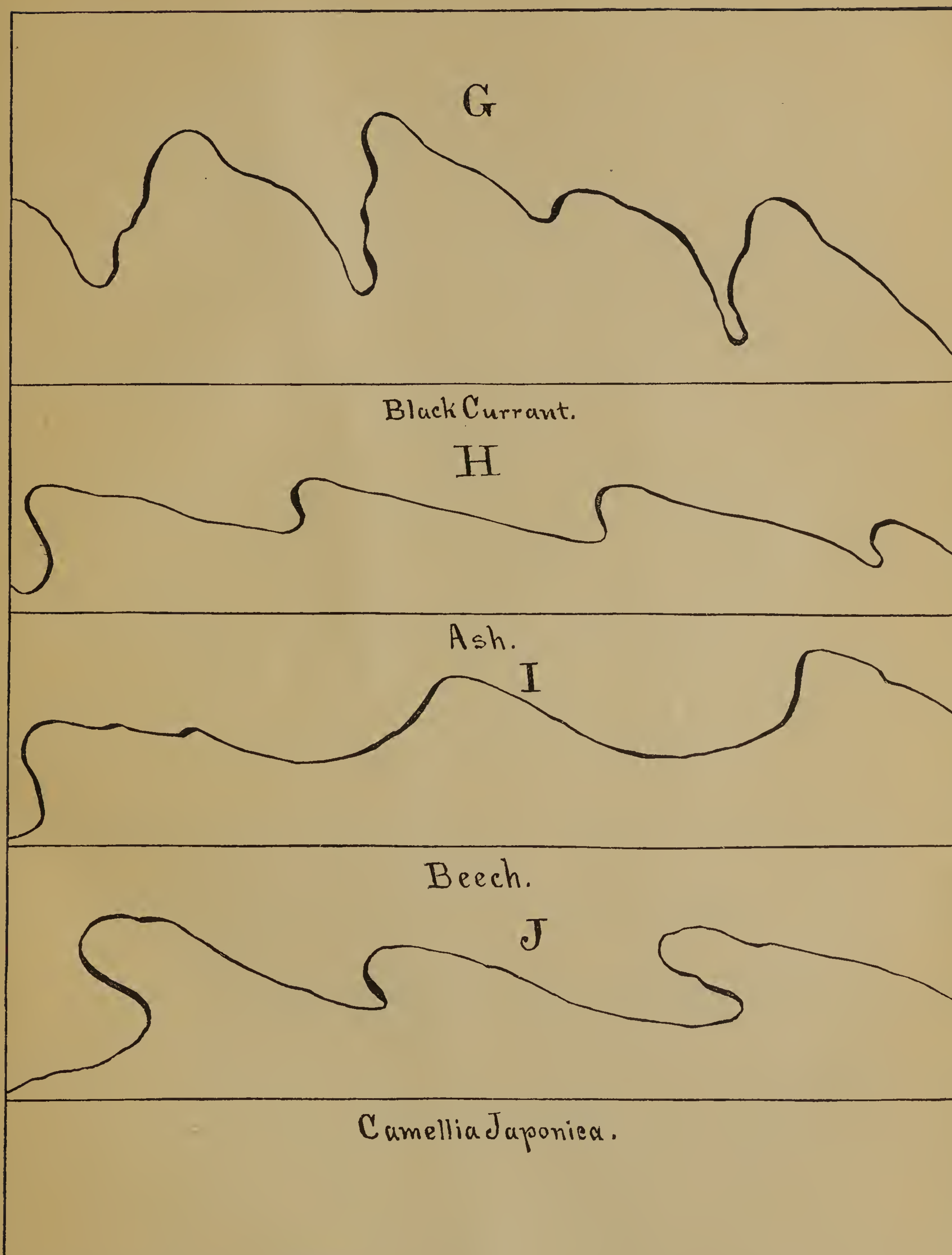
T. Taylor del.

TEA-LEAF AND ITS ADULTERANTS.



T. Taylor del.

DISTINGUISHING SERRATIONS OF THE TEA-LEAF AND ADULTERANTS CONTRASTED.



T. Taylor del.

DISTINGUISHING SERRATIONS OF THE LEAVES SOMETIMES MIXED WITH TEA-LEAVES.

OLIVE OIL, LARD, AND THEIR ADULTERANTS.

ORIGINAL INVESTIGATIONS RELATING TO COLOR REACTIONS.

Of late years the demand for olive oil as an article of food and for other purposes has greatly increased. This increased demand and the high price of the pure oil have led to a very extensive and fraudulent practice of adulterating it largely with seed oils. The olive growers of this country and of Europe say that no reliance can be placed upon the so-called olive oils of commerce, unless the buyer procures them directly from the grower, and they affirm that many samples of so-called olive oil consist mostly of cotton-seed oil, which in Italy is poured over the olives in the crusher to thoroughly mix the two oils. Very little pure oil, it is said, is obtainable even in Italy. Southern France has of late years suffered seriously from the artificial fabrication of this, one of her chief products; and the dilution of the olive oils of Nice and Provence with various seed oils has reduced their market value, according to the consular reports, below the point of profitable culture.

It is evident from the foregoing that the olive-oil industry of this country, if not protected by stringent laws, will suffer in like manner. This Department has lately been informed, by one of the leading olive cultivators of California, that although the olive oil of the United States is sold to dealers in its original purity, they mix with it cotton-seed oil, chiefly, but that they also use for this purpose various other seed oils, such as oil of sesame, walnut, sunflower-seed, poppy-seed, peanut, and even lard oil.

For the purpose of discovering new and useful tests for the adulterants of food fats and oils, I have made, during the past year, about fifteen hundred experiments, resulting in the use of the following named chemicals and chemical combinations as tests for the above mentioned adulterants:

Test A, 55 parts sulphuric acid, chemically pure, combined with 45 parts distilled water, by measure. Specific gravity of the mixture 1.575. Temp. 71°.6 Fah., 22° C.

Test B, 55 parts sulphuric acid, chemically pure, combined with 30 parts distilled water, by measure. Specific gravity 1.648. Temp. 71°.6 Fah., 22° C.

Test C, nitric acid, chemically pure. Specific gravity 1.42.

Test D, a solution of nitrate of silver in distilled water in the proportions of an ounce of nitrate of silver, in crystals, to an ounce of distilled water.

In the application of these tests to oils of any description I proceed as follows: Into a test-tube I first pour oil to the depth of about an inch and then an equal quantity of the acid solution. The tube is then corked, violently shaken, and after removal of the cork is placed on its rack. Changes in color should be noted at once. For this purpose I prepare drawings of test-tubes on card-board in advance, and copy the color reactions carefully as they progressively appear. The test-tubes for these experiments should be at least 7 inches long by five-eighths of an inch in diameter. This is especially desirable in the use of the nitric acid test, as the seed oils and lard oil decompose rapidly at about 78°.8 Fah., and will froth over even at a lower temperature, liberating the nitrous acid. The test-tubes should be placed in suitable racks.

The student will observe that in experiments with test B a deeper color is produced than in experiments with test A. With test C the

color reactions on evolution of the nitrous fumes are very interesting, the contrast between those of the true olive oils and those of lard oil and the seed oils showing forcibly the greater attraction of the latter for oxygen. The evolution of the nitrous acid takes place slowly at a temperature of 71°.6 Fah. (22° C.) in the case of the seed oils and lard oil; but if the mixture is exposed to the direct rays of the sun for a few seconds, the liberation of this acid is greatly accelerated, though not in the same degree with each variety of oil. In the case of the true olive oils, the evolution of nitrous acid is very slow, their decomposition, though not uniform in its progress for all varieties, always taking place far less rapidly than that of the other oils named, which is an important fact. The seed oils in all cases are wholly expelled from their test-tubes in the form of bubbles, charged with the fumes of the nitrous acid, while the olive oils, if pure, will manifest but little change under the same temperature. In using the nitric acid test on commercial olive oils (so called) some precaution is necessary in warm weather or in an apartment in which the temperature is above 72° Fah., as, if the olive oil is adulterated largely with cotton-seed oil, an explosion is liable to occur on shaking the test-tube, owing to the rapid evolution of the nitrous acid by the action of the nitric acid on the cotton-seed oil. Such an explosion actually occurred in the course of my own experiments at a temperature of about 72° Fah.

It will be seen in these experiments that, under the influence of each re-agent, two or more distinct layers are produced in the samples in the test-tubes. The lowest layer consists mostly of the test-acid and water, which is generally tinged according to the color reactions of the oil or fat used. The methods described have the advantage of enabling the observer to view several changes of color in the course of one and the same experiment. The success of the experiments depends wholly upon the strength and purity of the chemicals used. In testing several varieties of pure olive oil with concentrated nitric acid the similarity of the color reactions of all the samples is remarkable. Lard oil (which requires further investigation) is similar to olive oil in its color reactions under this test, even to the bands of green and yellow resting on the acid in the test-tube. (See Plate 3, Fig. 1, section *d.*) If the oil of sesame is present in olive oil it may be detected by either test A or B. By the former as small an amount of the adulterant as 5 per cent. may be perceived. By test B a well defined violet tinge is shown in the lower layer in the test tube, and a dark band, characteristic of the oil of sesame, is observed above this, about midway of the tube. The color reactions of the oil of sesame, treated with test A, are different from its color reactions under test B. (See Plate 4, Figs. 3 and 4.)* Pure raw linseed oil under test A yields a most beautiful green color and is opaque, without the dark dividing band observed when this test is applied to the oil of sesame. In the latter case the width of the dark band is proportional to the amount of the oil of sesame used.

*In Figs. 5 and 6 of this plate I have departed from my usual method of mixing the test-acid and the oil or oils by shaking the tubes, in order to ascertain whether the oil of sesame combined with cotton-seed oil would be affected simply by contact with the acid-test without intermixture, and also to note the effect produced by the stronger acid in comparison with that of the weaker. The acid in Fig. 5, test B, almost immediately indicated the presence of the oil as illustrated (see Plate 4, section *a*), while with the weaker acid the indications of sesame did not appear until the day following—showing that oil of sesame when combined with any oil may be quickly detected by the use of the stronger acid-test B.

PLATE 1.

Sections *a*, *b*, and *c* represent the progressive color reactions of seven varieties of pure olive oil. The first six samples were received from the Quito Olive Farm, Santa Clara, Cal.; the seventh sample was from the Bijou Farm, Riverside, Cal. The samples were labeled, respectively, Coreggiolo, Razzo, Mission No. 1, Marajolo, Mission No. 2, Virgin oil, Mission No. 3 (from olives grown in the interior valley, heavy soil, trees irrigated), and are shown in this order in the test-tubes numbered from left to right. Sulphuric acid (test A*) is used. Section *d*, same plate, represents the color reactions of a mixture of cotton-seed oil and known pure lard, combined with benzine in equal proportions. Section *e* represents the color reactions of pure lard dissolved in benzine in the proportions of one of melted lard to two of benzine by measure. In this experiment a solution of nitrate of silver (test D†) is used. The benzine is used in both mixtures to get the lard into a minute state of division and allow the nitrate free access. The color reactions in this case are as observed twenty-four hours after the test was applied. It will be observed that the tubes containing the cotton-seed oil show a yellow color, which represents the cotton-seed oil, while figure 7, section *e*, pure lard, shows no appearance of yellow. The proportion of cotton-seed oil used in the first six tubes is one-half, one-third, one-fourth, one-eighth, one-sixteenth, and five drops, respectively. This section illustrates a method of detecting cotton-seed oil in lard.

PLATE 2.

Sections *a*, *b*, *c*, and *d* represent the progressive color reactions of seven varieties of pure California oilve oil. The nitric acid test (C.‡) is used here. Here as in my other plates the tests tubes are classed in sections for the sake of convenience, the figures denoting the respective oils being the same in each section.

FIG. 1. Coreggiolo.
FIG. 2. Razzo.
FIG. 3. Mission No. 1.
FIG. 4. Marajolo.
FIG. 5. Mission No. 2 (another variety).
FIG. 6. Vergine Oleo. (The first running out of the oil under weigh of the "bruscole" or sacks without mechanical pressure.)
FIG. 7. Mission No. 3.

Section *d* represents not only the advanced color reactions but the progress of the oils in decomposition.

PLATE 3.

Sections *a*, *b*, *c*, and *d* represent the progressive color reactions of the seed oils and lard oil used as adulterants of the pure olive oil. The nitric acid test (C.§) is here used.

FIG. 1. Pure lard oil, which exhibits under this test color reactions similar to those of pure olive oil. (See plate 2.)
FIG. 2. Pure cotton-seed oil.
FIG. 3. Peanut oil.
FIG. 4. Poppy-seed oil.
FIG. 5. Oil of sesame.
FIGS. 6 to 13, inclusive, pure raw linseed oil.

All the above oils oxidize quickly at a temperature of 76° Fah. At 85° Fah. they almost instantly decompose. Any combination of these oils with pure olive oil under this test causes a rapid decomposition even at a temperature of 75° Fah. By this test any sophistication of the pure olive oil with these oils may be detected.

PLATE 4.

Sections *a*, *b*, *c*, and *d* represent the progressive color reactions of, principally, oil of sesame. This oil is more easily detected than any of the seed oils used as an adulterant of olive oil.

FIG. 1. Oil of sesame with an equal portion of pure olive oil, under test B.‖ It is highly important to note the difference in color produced according to the specific gravity of the acid used in this test.

* Dilute sulphuric acid chemically pure, specific gravity 1.575, temperature 71°.6 Fah., 22°C.
† Nitrate of silver, 1 to 2 ounces of distilled water.
‡ Chemically pure nitric acid; specific gravity 1.42, temperature 71°.6 Fah., 22° C.
§ Chemically pure nitric acid; specific gravity, 1.42.
‖ Dilute sulphuric acid, chemically pure; specific gravity 1.648, temperature 71°.6 Fah., 22° C.

FIG. 2. Oil of sesame with an equal portion of pure olive oil under test A.*

FIG. 3. Oil of sesame under test B, the oil and the re-agent being in equal proportions.

FIG. 4. Oil of sesame under test A, in equal proportions.

FIG. 5. Oil of sesame and cotton-seed oil in equal proportions under test B.

FIG. 6. Ten per cent. of the oil of sesame, with olive and cotton-seed oils in equal proportions, under test A. In Figs. 5 and 6 the contents of the tubes were not intimately mixed by agitating them until twenty-four hours after the tubes were filled. The contents of Fig. 5, section *a*, indicated the presence of the oil of sesame almost immediately by the dark neutral tint fringing the oil as it rested on the acid. The contents of Fig. 6, same section, but faintly exhibited the purplish color on the day following. On agitating the contents of tubes 5 and 6, the color reactions as represented in sections *b*, *c*, and *d* were observed progressively.

PLATE 5.

Sections *a*, *b*, *c*, and *d* represent the progressive color reactions of pure lard and mixtures of pure lard with cotton-seed oil under the sulphuric acid test A,† using equal portions of benzine in each case as a solvent of the lard.

FIG. 1. Pure lard.

FIG. 2. Pure lard and cotton-seed oil in equal parts.

The test tubes in sections *c* and *d*, Figs. 1 and 2 respectively, represent the appearance of the color reactions after a lapse of seventy-two hours.

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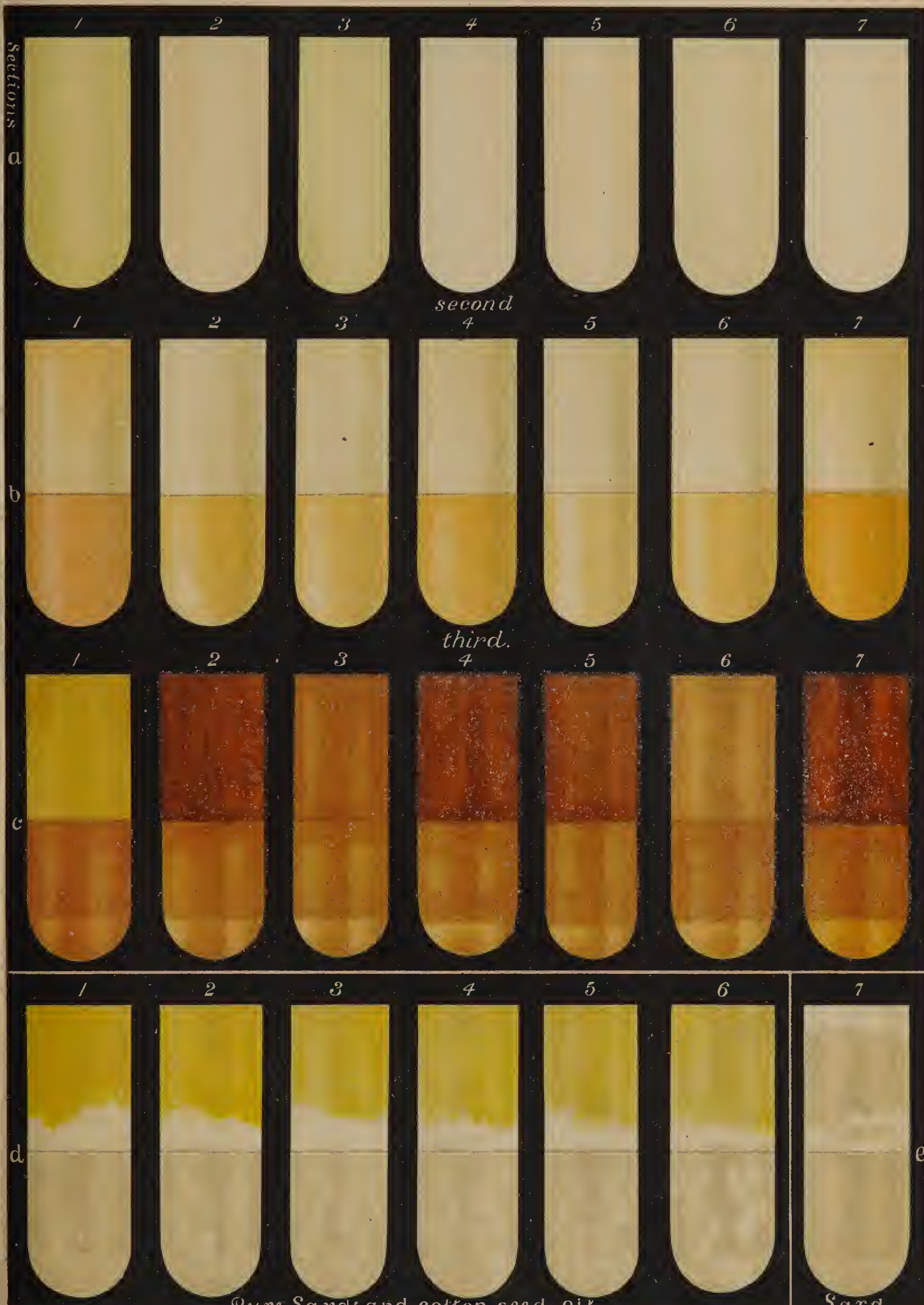
* Dilute sulphuric acid, chemically pure; specific gravity 1.575, temperature 71°.6 Fah., 22° C. All proportions in these experiments not otherwise expressed are by measure.

† Dilute sulphuric acid, chemically pure; specific gravity 1.575, temperature 71°.6 Fah., 22° C.

OLIVE OILS
seven varieties
Sections a b and c under test A
First color reaction.

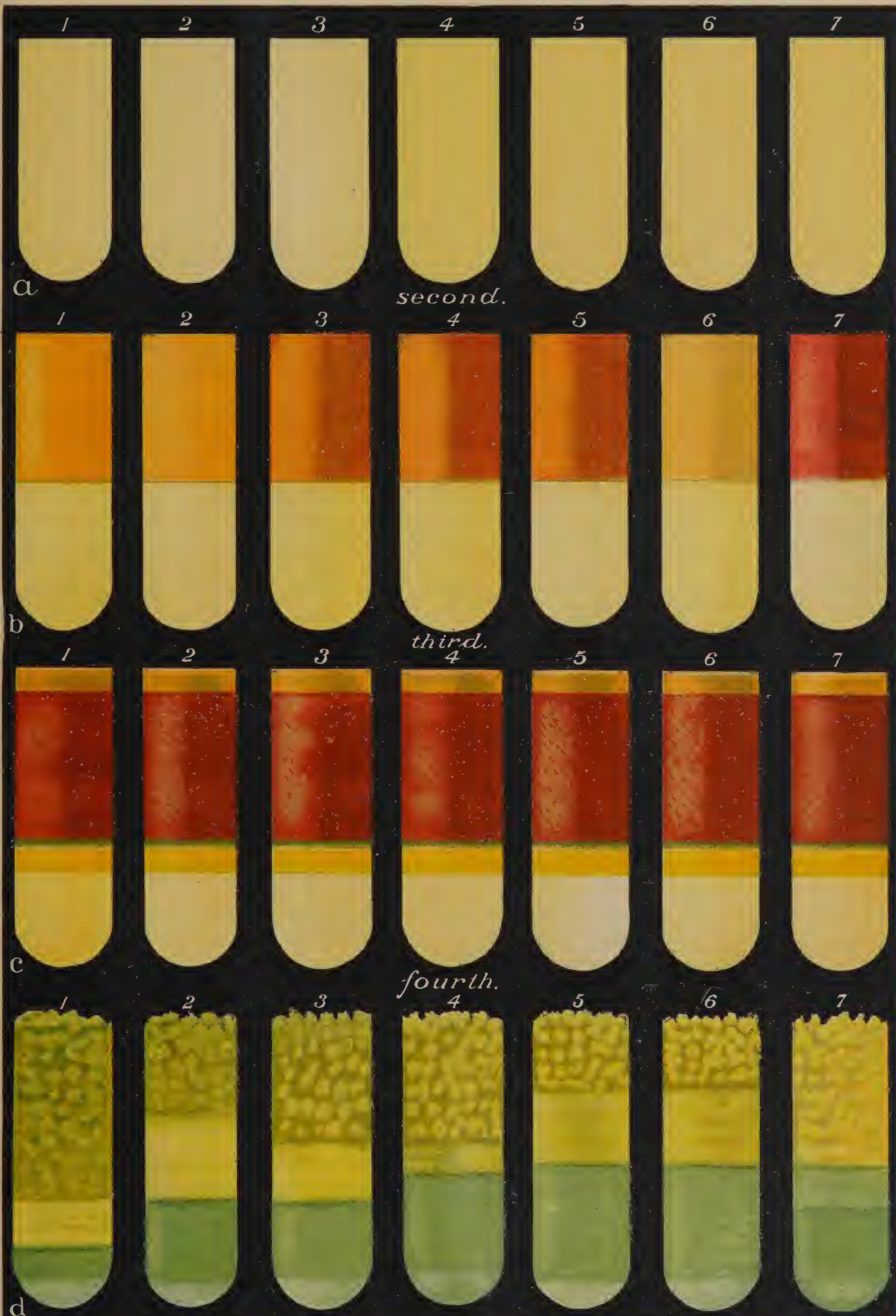


T. Taylor del.

Geo. S. Harris & Sons, Lith. Phila.

Sections d and e under silver test

OLIVE OILS
seven varieties
Sections a b c and d under test C *
First color reaction.



T. Taylor del.

Geo. S. Harris & Sons, Lith. Phila.

Last stage under decomposition

(* C Nitric acid Sp. gr. 1.42.)

COLOR REACTION
of the seed oils including lard adulterants
of olive oil and lard
under test C ☆

T. Taylor del.

Geo. S. Harris & Sons, Lith Phila.

Lard oil. Cotton-seed oil. Peanut oil. Poppy-seed oil. Sesame oil. Raw Linseed oil.

(☆ Nitric acid Sp. gr. 1.42.)

COLOR REACTION
of
Lard and cotton seed oil and Lard under test A.

T. Taylor del. Geo. S. Harris & Sons, Lith. Phila.

Pure Lard and benzine. Pure Lard, cotton-seed oil and benzine.